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Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser[1]

This standard is issued under the fixed designation D4060; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope*

1.1 This test method covers the determination of the resistance of organic coatings to abrasion produced by the Taber Abraser on coatings applied to a plane, rigid surface, such as a metal panel.

~~1.2Because of the poor reproducibility of this test method, it should be restricted to testing in only one laboratory when numerical abrasion resistance values are to be used. Interlaboratory agreement is improved significantly when rankings of coatings are used in place of numerical values.~~

~~1.3The values stated in SI units are to be regarded as the standard, with the exception of mils when determining coating thickness. The values given in parentheses are for information only.~~

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1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D823 Practices for Producing Films of Uniform Thickness of Paint, Varnish, and Related Products on Test Panels

D968 Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive

D1005 Test Method for Measurement of Dry-Film Thickness of Organic Coatings Using Micrometers

D2240 Test Method for Rubber PropertyDurometer Hardness

D3924 Specification for Environment for Conditioning and Testing Paint, Varnish, Lacquer, and Related Materials

D7091 Practice for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to Ferrous Metals and Nonmagnetic, Nonconductive Coatings Applied to Non-Ferrous Metals

2.2 *Other Standards:*

ISO 7784–2 Paints and varnishes—Determination of resistance to abrasion—Part 2: Rotating abrasive rubber wheel method[3]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 Abrasion resistance can be expressed as one or more of the following terms:

3.1.2 *wear index*, *n*—1000 times the loss in weight in milligrams per cycle.

3.1.3 *weight loss*, *n*—the loss in weight in milligrams, determined at a specified number of cycles.

3.1.4 *wear cycles per mil*, *n*—the number of cycles of abrasion required to wear a film through to the substrate per mil of film thickness.

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[1] This test method is under the jurisdiction of ASTM Committee D01 on Paint and Related Coatings, Materials, and Applications and is the direct responsibility of Subcommittee D01.23 on Physical Properties of Applied Paint Films.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website. ~~DOI: 10.1520/D4060-07.~~

[3] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

***A Summary of Changes section appears at the end of this standard.**

4. Summary of Test Method

4.1 The organic coating is applied at uniform thickness to a plane, rigid panel and, after curing, the surface is abraded by rotating the panel under weighted abrasive wheels.

4.2 Abrasion resistance is calculated as loss in weight at a specified number of abrasion cycles, as loss in weight per cycle, or as number of cycles required to remove a unit amount of coating thickness.

5. Significance and Use

5.1 Coating on substrates can be damaged by abrasion during manufacturing and service. This test method has been useful in evaluating the abrasion resistance of attached coatings. Ratings produced by this test method have correlated well with ratings produced by the falling abrasive values in Test Methods D968.

5.2 For some materials, abrasion tests utilizing the Taber ~~abraser~~Abraser may be subject to variation due to changes in the abrasive characteristics of the wheel during testing. Depending on abradant type and test specimen, the wheel surface may change (that is, become clogged) due to the pick-up of coating or other materials from test specimens and must be refaced at more frequent intervals as agreed upon by the interested parties. To determine if more frequent refacing is required, plot the total weight loss every 50 cycles. If a significant negative change in slope is observed prior to 500 cycles, the point at which the slope changes determines the refacing frequency.

6. Apparatus

6.1 *Taber Abraser,*[4] consisting of the following elements:

~~6.1.1A~~6.1.1 A horizontal turntable platform; comprised of a rubber pad, clamp plate, and nut to secure the specimen to the turntable,

6.1.2 A motor capable of rotating the turntable platform at a speed of either 72 ± 2 r/min for 110v/60Hz or 60 ± 2 r/min for 230v/50Hz,

6.1.3 A pair of pivoted arms, to which the abrasive wheels and auxiliary masses may be attached; loads of 250, 500, or 1000 g on each wheel may be obtained by use of these changeable masses. Counterweight attachments of 125 or 175 g are available to reduce the load against the specimen, and can be used with or without the ~~accessory~~auxiliary masses,

NOTE 1—Without auxiliary masses or counterweights, each arm will apply a load against the specimen of 250 g per wheel (exclusive of the mass of the wheel itself).

6.1.4 A vacuum suction system and vacuum pick-up nozzle to remove debris and abrasive particles from the specimen surface during testing. The height of the vacuum pickup nozzle shall be adjustable, and the nozzle openings shall be 8 mm (5⁄16 in.) in diameter. The vacuum system shall operate when testing commences.

6.1.5 A counter to record the number of cycles (revolutions) made by the turntable platform.

6.2 *Abrasive Wheels*—Resilient Calibrase wheels No. CS-10 or CS-17, as required, shall be used unless otherwise agreed upon by the interested parties. Because of the slow hardening of the bonding material resilient wheels should not be used after the date marked on them, or one year after their purchase if the wheels are not dated.

~~6.2.1The~~6.2.1 The wheels shall be 12.7 ± 0.3 mm thick and have an external diameter of 51.9 ± 0.5 mm when new, and in no case less than 44.4 mm.

NOTE 2—The hardness of the wheels can be checked by Test Method D2240. Measure at least four points equally spaced on the side surface of the wheel. The reading shall be taken 10 s after full application of the pressure, and then averaged. An acceptable hardness for both types of wheels is 81 ± 5 units on Shore Durometer A-2 Scale.

NOTE 3—The CS-17 wheels produce a harsher abrasion than the CS-10 wheels.

6.3 *Resurfacing Medium*, an S-11 abrasive disk, used for resurfacing the abrasion wheels.

7. Test Specimens

7.1 Apply a uniform coating of the material to be tested to a rigid panel having both surfaces substantially plane and parallel. Specimens shall be a disk or a square plate with a 6.5 mm (¼ in.) hole centrally located on each panel. Typical dimensions for a test panel are 100 mm in diameter or 100 by 100 mm. Thickness of the specimen should be no greater than 6.3 mm (¼ in.) unless ~~as~~an S-21 extension nut[4] or arm height extension kit[4] is utilized. Prepare a minimum of two coated panels for the material.

NOTE 4—The coatings should be applied in accordance with Practices D823, or as agreed upon between the interested parties.

NOTE 5—The thickness of the dry coatings should be measured in accordance with Test ~~Methods~~Method D1005 or Practice D7091.

NOTE 6—For those materials greater than 6.3 mm (¼ in.) but less than 12.7 mm (½ in.) thick, the S-21 extension nut may be used to affix the specimen to the turntable. This requires a 9.5 mm (⅜ in.) center hole in the specimen. Alternatively, an arm height extension kit will permit testing of specimens up to 40 mm (1½ in.) thick and requires the center hole to be 14.5 mm (9⁄16 in.).

8. Calibration

8.1 Verify calibration of the Taber ~~abraser~~Abraser as directed by the equipment manufacturer (see Appendix X1).

[4] Available from Taber Industries, 455 Bryant St., North Tonawanda, NY 14120.

9. Standardization

9.1 To ensure that the abrading function of the wheels is maintained at a constant level, prepare the abrading wheels prior to each test.

9.1.1 Mount the selected abrasive wheels on their respective flange holders, taking care not to handle them by their abrasive surfaces.

9.1.2 A load of 1000 g (per wheel) should be used, unless otherwise agreed upon by the interested parties.

9.1.3 Mount the resurfacing medium (S-11 abrasive disk) on the turntable. Lower the abrading heads carefully until the wheels rest squarely on the abrasive disk. Place the vacuum pick–up nozzle in position and adjust it to a distance of 6.5 mm (¼ in.), or as agreed upon between buyer and seller, above the abrasive disk.

9.1.4 Set the counter to "zero" and set the vacuum suction force to 100. The vacuum suction force may be decreased if agreed upon by the interested parties.

~~9.1.5Resurface~~9.1.5 Resurface the wheels by running them 50 cycles against the resurfacing medium. **Warning**—Do not brush or touch the surface of the wheels after they are refaced.

NOTE 7—The wheels shall be resurfaced in this manner before testing each specimen and after every 500 cycles.

10. Conditioning

~~10.1Cure the coated panel under conditions of humidity and temperature as agreed upon between the interested parties.~~

10.1 Cure the coated panel under conditions of humidity and temperature as agreed upon between the interested parties. For additional information, reference Specification D3924.

10.2 Unless otherwise agreed upon between the interested parties, condition the coated panel for at least 24 h at 23 ± 2°C (73.4 ± 3.6°F) and 50 ± 5 % relative humidity. Conduct the test in the same environment or immediately on removal therefrom.

11. Procedure

11.1 Weigh the test specimen to the nearest 0.1 mg and record this weight, if either the wear index or the weight loss is to be reported.

11.2 When wear cycles per mil is required, measure the coating thickness of the test specimen on four points along the path to be abraded and take the average of the readings.

11.3 Mount the test specimen on the abraser turntable platform with the side to be abraded facing up. Secure using the clamp plate and nut. Place the abrading heads on the test ~~film~~specimen and the vacuum pick-up nozzle in position as outlined in 9.1.3. Affix the auxiliary masses as outlined in 9.1.2. Set the counter and vacuum suction as outlined in 9.1.4.

NOTE 8—To generate a uniform wear pattern, specimen surfaces must be plane and parallel. If a sample is slightly warped, the model E140-14 Rimmed Specimen Holder with Ring Clamp~~5~~[4] or similar may be used. This holder clamps the sample against a flat rigid plate about the perimeter of the sample.

NOTE 9—If using a dual table abraser and the second table is not in use, mount a sample to the table and set the vacuum nozzle height as stated in 9.1.3.

11.4 Subject the test specimen to abrasion for the specified number of cycles or until wear through of the coating is observed. In determining the point of wear through, stop the instrument at intervals for examination of the test specimen.

11.5 Remove any loose abradings remaining on the test specimen by light brushing. Reweigh the test specimen.

11.6 Repeat 11.1-11.5 on at least one additional test specimen of the material under test.

12. Calculation

12.1 *Wear Index*—Compute the wear index, *I*, of a test specimen as follows:

(1) $I = (A - B)\ 1000\ C$

TABLE 1 Precision of Taber Abrasion Values[A]

Coating	Average	Repeatability Standard Deviation	Reproducibility Standard Deviation	Repeatability Limit	Reproducibility Limit
	$\bar{x}$	sr	sR	r	R
Polyamide/Epoxy Coating A	129.6	3.1	15.3	8.7	43.0
Polyamide/Epoxy Coating B	109.1	14.6	19.1	40.9	53.6
Polyurethane Coating	49.5	3.0	6.1	8.3	17.2
Polyester/Epoxy Powder Coating	61.3	2.6	6.8	7.1	19.1
Nylon Powder Coating	7.7	1.6	3.2	4.4	8.9

[A] Weight loss (milligrams).